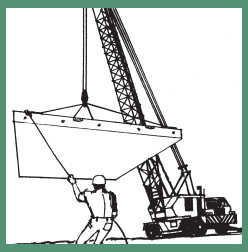
Guide

Erection Safety for Precast and Prestressed Concrete



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ERECTION SAFETY FOR PRECAST AND PRESTRESSED CONCRETE

prepared by

PCI ERECTORS COMMITTEE
CARL HARRIS, Chair

IVO ALLAS
RICHARD BALDWIN
MARK L. BIEBIGHAUSER
JERRY DUNCAN
SKIP FRANCIES
SIDNEY FREEDMAN
FRANCESCO GENOESE
*GREGORY B. GIBBONS**
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JUNE SPARROW
ROBERT SWEEN
AARON VNUK
GARY WILDUNG
AL WILLIAMS

**Chair during preparation of current edition*

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INTRODUCTION

This safety manual has been prepared for the use and training of precast and prestressed concrete erecting personnel. It sets forth rules that must be observed in order to safely and efficiently carry out erection work. All employees should cooperate in making their work safer by strictly adhering to these rules.

This manual does not replace the need for employers to develop their own safety programs. It should be used in conjunction with each employer's own written safety manual and code of safe practices. This manual outlines some of the OSHA regulations. However, there are many regulations that this manual does not mention. You should periodically refer back to this manual and to the most recent federal, state, and local construction safety and health standards to refresh your memory. You should also share this information with your crew so that they may increase their safety awareness and recognize and avoid unsafe conditions. Unsafe conditions must be recognized and corrected immediately. Any reference to safety factors within this document implies adherence to minimum OSHA standards.

Safety is a state of mind, and supervision should instill this state of mind in the crew by constant reminder. The supervisor must establish and maintain direct, personal communication. People respond better to other people than to words in policy statements, booklets, or pamphlets. But, as with all personal communications, the suggested methods of accident prevention must be communicated while keeping a clear distinction, and high degree of respect, for the other person's position and responsibilities. There is no effective substitute for face-to-face communications when enlisting another's efforts to achieve a safe and healthful work environment.

Personnel involved in the use and operation of equipment must be competent, careful, physically and mentally qualified, and trained in the proper operation of the equipment and the handling of loads. Serious hazards include, but are not limited to, improper or inadequate maintenance, overloading, dropping or slipping of the load, obstructing the free passage of the load, and using equipment for a purpose for which it was not designed.

Care and common sense are the greatest assets you can possess. You must constantly think and visualize what the actions of your crew are or will be. The majority of unsafe conditions or accidents can be attributed to someone causing an obvious unsafe condition. The delegation of specific tasks within the erection crew is your responsibility, and you should be satisfied that the person to whom a task is assigned is competent to carry out that work safely. In today's work atmosphere, it is unacceptable to sacrifice safety for efficiency. A small investment in time and money to make a jobsite safer will, in the long run, ensure a more efficient company and a less costly job.

GLOSSARY*

Aerial work platforms (AWP) – hydraulically operated personnel carrier, often called "aerial lifts" or "manlifts."

Anchorage – a secure point of attachment for lifelines, lanyards, or deceleration devices.

Angle indicator (boom) – an accessory that measures the angle above or below horizontal of the longitudinal axis of the base boom section centerline.

Anti-two-block device – a device that, when activated, disengages all crane functions whose movement can cause two-blocking.

Barring – to move or adjust a member with a steel pry bar.

Basket hitch – see Choker.

Belt – commercially manufactured cloth, synthetic nylon web, or wire mesh strip with eyes at each end, used when a wire rope sling could damage the member.

Binder (load binder) – a lever-actuated device used to tighten chain. Most often used on transport vehicles to secure loads.

Bloodborne pathogens –microorganisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV).

Body harness, full – straps that may be secured about the employee in a manner that will distribute the fall arrest forces over at least the thighs, pelvis, waist, chest and shoulders with means for attaching it to other components of a personal fall arrest system such as a lanyard, lifeline, or deceleration device.

Boom – the hinged structural member of a crane or derrick used to carry the weight of the load and to project the upper end of the hoisting tackle in reach or in a combination of height and reach. On tower cranes: if the "boom" (that is, the principal horizontal structure) is fixed, it is called a jib; if it is moveable up and down, it is called a boom.

Boom hoist limiting device – disengages boom hoist power when the boom reaches a predetermined operating angle. It also sets brakes or closes valves to prevent the boom from lowering after power is disengaged.

Boom stop – a device used to restrict the boom from moving above a certain maximum angle and toppling over backward.

Bull wheel – a large diameter, horizontally mounted wheel situated at the bottom of the derrick mast and boom. Wire ropes are wound around the wheel and attached to winches at each end. Used to swing the derrick boom.

Caulking – see Sealant.

Center of gravity - the point in the object around which its weight is evenly distributed.

Certified welder – person holding a certificate as proof that qualified test welds have been performed and passed in accordance with the governing welding code.

Chain fall – hand-operated lifting device employing a continuous pull chain to raise and lower the hook.

Chicago boom – a boom that is attached to a structure, an outside upright member of the structure serving as the mast, and the boom being stepped in a fixed socket clamped to the upright.

Choker – sling or wire rope with eyes, spliced on each end used to lift load; sling is placed around the load and attached back to itself forming a noose that tightens on the load.

Closed link (master link) – an alloy steel, oblong ring, commonly used between more than one sling and the load block.

Come-a-long – a lever and ratchet-operated pulling device that uses a wire rope or chain to facilitate movement of an object through leverage.

Competent person – one who is capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous, or dangerous to employees, and who has the authority to take prompt corrective measurers to eliminate them.

* For additional "Glossary" terms' definitions, meanings, and uses, refer to "A Glossary of Common Crane & Rigging Terms," Specialized Carriers & Rigging Association, Fairfax, VA, 1997, 67 pp.

Connector – a device that is used to couple (connect) parts of the personal fall arrest system and positioning device systems together. It may be an independent component of the system, such as a carabiner, or it may be an integral component of part of the system (such as a buckle or D-ring sewn into a full body harness, or a snaphook spliced or sewn to a lanyard or self-retracting lanyard).

Contractor's hardware – items to be placed on or in the structure in order to receive the precast concrete units; for example, anchor bolts, angles, or plates with suitable anchors.

Controlled access zone (CAZ) – an area in which certain work (for example, initial installation and placement of floor or roof members) may take place without the use of guardrail systems, personal fall arrest systems, or safety net systems, and access to the zone is controlled.

Controlled load lowering – lowering a load by means of a mechanical hoist drum device that allows a hoisted load to be lowered with maximum control using the gear train or hydraulic components of the hoist mechanism. Controlled load lowering requires the use of the hoist drive motor, rather than the load hoist brake, to lower the load.

Controlling contractor – a prime contractor, general contractor, construction manager, or any other legal entity that bears overall responsibility for the planning, quality, and completion of the project.

Counterweight – weight used to supplement the weight of the machine in providing stability for lifting working loads.

Cribbing – wood or other material used to support equipment or a component and distribute loads to the ground. Typically used to support latticed boom sections during assembly/disassembly and under outrigger floats.

Critical lift – a lift that exceeds 75% of the rated capacity of the crane or derrick, at the given radius, or requires the use of more than one crane or derrick.

Dead end – fixed end of a live hoisting line.

Deceleration device – any mechanism, such as a rope grab, rip-stitch lanyard, specially woven lanyard, tearing or deforming lanyards, automatic self-retracting lifelines/lanyards, etc., that serves to dissipate a substantial amount of energy during a fall arrest, or otherwise limit the energy imposed on an employee during fall arrest.

Deceleration distance – the additional vertical distance a falling employee travels, excluding lifeline elongation and free-fall distance, before stopping, from the point at which the deceleration device begins to operate. It is measured as the distance between the location of an employee's full body harness attachment point at the moment of activation (at the onset of fall arrest forces) of the deceleration device during a fall, and the location of that attachment point after the employee comes to a full stop.

Derrick – a device for raising, lowering, and moving loads laterally through the use of a hoisting mechanism employing ropes, but whose hoisting engine is not an integral part of the machine. Derricks rely on the structure on which they are mounted for their rigidity and stability.

Designated erector – a person selected or assigned by the employer or the employer's representative to perform a specific type of duty or duties at a specific location or locations at the jobsite.

D-Ring – (1) attachment point(s) on the belt or harness for a device or lanyard (sometimes erroneously named for a carabiner snaphook) or (2) the swiveling portion of a lifting plate to which the hoisting sling is attached.

Dynamic load – shifting load that can increase the impact on hoisting devices and rigging.

Engineer of record – engineer who develops original building design and is responsible for the design of the building or structure of which the precast concrete forms a part.

Erection hardware – all loose hardware necessary for the installation and final connections of the precast concrete units.

Erection safety plan – erection drawings that address the stability of the building or components; safety manuals that include specific provisions for the safety of employees and address precast concrete erection hazards; and the fall protection plan.

Erection sequence – a list of precast pieces in the order in which they are anticipated to be erected.

Equalizer beam – a structural rigging component used to equalize or distribute sling loads in a desired proportion or between cranes in a dual lift (see following figure).

Eye – a loop formed at the end of a rope by securing the dead end to the live end at the base of the loop.

Fall protection – equipment and methods designed to prevent or arrest a person's fall.

Fall protection plan – a document that discusses what fall protections will be used and the reasons why the use of conventional fall protection systems is infeasible or why their use would create a greater hazard. It includes a discussion of other measures that will be taken to reduce or eliminate fall hazards.

Fall protection training – Specific training containing the elements identified in 29 CFR Part 1926.503a.

Fall restraint system – a fall protection system that prevents the user from falling any distance. The system is comprised of a full body harness, along with an anchorage, connectors, and other necessary equipment. The other components typically include a lanyard, and may also include a lifeline and other devices.

Flemish eye – a method of forming an eye splice in the end of a wire rope that provides 100% efficiency when used with a pressed metal (swaged) sleeve.

Free fall – the act of falling before a personal fall arrest system begins to apply force to arrest the fall.

Free fall distance – the vertical displacement of the fall arrest attachment point on the employee's full body harness between onset of the fall and just before the system begins to apply force to arrest the fall. This distance excludes deceleration distance, and lifeline/lanyard elongation, but includes any deceleration device slide distance or self-retracting lifeline/lanyard extension before they operate and fall arrest forces occur.

Genie hoist – a small electric, gear reduced, vertical winch, most often used on swing stages.

Greater hazard – the exposure to and potential for falls is increased by the use of conventional fall protection.

Guardrail system – a barrier system erected along the open sides and ends of platforms as well as along the perimeter of unguarded roofs, floors, and roof and floor holes to prevent employees from falling to lower levels. The rail system consists of toprails, midrails, toeboards, and their supports.

Guy derrick – a derrick whose boom is supported by wire ropes running between the boom tip and the top of a mast supported by guy wires running from the mast tip and anchored into the supporting surface.

Headache ball – a weighted hook that is used to attach loads to the hoist load line of the crane.

Hoisting equipment – commercially manufactured lifting equipment designed to lift and position a load of known weight to a location at some known elevation and horizontal distance from the equipment's center of rotation.

Hole – a gap or void, 2 in. or more in its least dimension, in a floor, roof, or other walking/working surface in which persons may trip or fall into or where objects may fall to the level below.

Infeasible – it is impossible to perform the construction work using a conventional fall protection system (that is, guardrail system, safety net system, or personal fall arrest system) or it is technologically impossible to use any one of these systems to provide fall protection.

Jib (fly jib) – an articulating or fixed boom assembly with or without extendable boom sections that attaches at or near the boom tip. Can be mounted in line with the boom axis or offset at an angle to the boom axis.

Job hazard analysis – a written analysis that defines and controls the hazards associated with certain processes.

Lanyard – a flexible line of rope, wire rope, or strap that generally has a connector at each end for connecting the full body harness to a deceleration device, lifeline, or anchorage for fall arrest, positioning, or restraint purposes.

Lattice boom – a boom constructed of three or four corner members (chords) assembled with transverse and diagonal members (lacings or lattices) to form a trusswork. The chords carry the axial boom forces and the bending moments while the lacings resist shear.

Lay – signifies the direction of rotation of the strands in a wire rope.

Lay length – distance measured along a rope in which a strand makes one complete revolution about the rope axis.

Layout – the process of surveying to mark the location of precast concrete members in preparation for subsequent erection operations.

Leading edge – the edge of a floor, roof, or other walking/working surface that changes location as additional floor or roof sections are placed or constructed. A leading edge is considered to be an "unprotected side and edge" during periods when it is not actively and continuously under construction.

Lifeline – a component that consists of a flexible line for connection to an anchorage at one end to hang vertically (vertical lifeline), or for connection to anchorages at both ends to stretch horizontally (horizontal lifeline), and that serves as a means for connecting other components of a personal fall arrest system to the anchorage.

Lifting anchors – cast-in devices used to lift precast units.

Lifting capacity (rated capacity) – the maximum working load permitted by the manufacturer under specified working conditions. Such working conditions typically include a specific combination of factors such as equipment configuration, radii, boom length, and other parameters of use.

Lifting hardware – metallic inserts in or attachments to lifting anchors to facilitate handling.

Load – the weight of the object being lifted or lowered, including the weight of the load-attaching equipment such as the load block, ropes, slings, shackles, and any other ancillary attachment.

Load block – an assembly of a hook or shackle plus swivel, bearings, sheaves, pins, and frame suspended at the lower end of a reeved system of hoisting lines.

Load moment (or rated capacity) indicator – a system that aids the equipment operator by sensing the overturning moment on the equipment, that is, load × radius. It compares this lifting condition to the equipment's rated capacity, and indicates to the operator the percentage of capacity at which the equipment is working.

Luffing – a term used with derricks to indicate raising or lowering the boom, which changes the boom angle with respect to horizontal.

Material safety data sheets (MSDS) – chemical manufacturer's written or printed material containing information concerning a hazardous chemical prepared in accordance with 29 CFR Part 1910.1200(g).

Mobile crane – a type of crane that can move freely about the jobsite under its own power without being restricted to a predetermined path of travel.

Near miss – an incident that does not result in an injury to a worker.

Opening – a gap or void 30 in. or more high and 18 in. or more wide, in a wall or partition, through which employees can fall to a lower level.

OSHA – U.S. Department of Labor, Occupational Safety and Health Administration.

Outriggers – extendable or fixed members that are attached to the mounting base, rest on supports at the outer ends, and are used to support the hoisting equipment.

Part of line – indicates the number of wire ropes supporting a load to provide mechanical advantage to a system.

Personal fall arrest system – a system used to arrest an employee in a fall from a working level. It consists of an anchorage, connectors, and a full body harness and may include a lanyard, deceleration device, lifeline, or suitable combinations of these. As of January 1, 1998, the use of a body belt for fall arrest is prohibited.

Personal protective equipment – protective equipment for eyes, face, head, and extremities; protective clothing; respiratory devices; and protective shields and barriers necessitated by hazards of processes or environment, including chemical hazards, radiological hazards, or mechanical irritants capable of causing injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact.

Pick – individual lift made with a crane.

Pick point – location of individual lifting anchors.

Piece – An individual unit of precast concrete.

Positioning device system – a body belt or full body harness system rigged to allow an employee to be supported on an elevated vertical surface, such as a wall, and work with both hands free while leaning.

Qualified person – one who has successfully demonstrated the ability to solve problems relating to the subject matter, the work, or the project, either by possession of a recognized degree, certificate, or professional standing, or by extensive knowledge, training, and experience.

Rebar – reinforcing steel bar.

Reeve – to pass a line through an opening or around a pulley or sheave; the process of passing cable through sheaves to create multipart lines.

Rendering – the movement of a cable through a rolling block to equalize the force on each lift point.

Retractable lanyard – a deceleration device containing a drum/wind that can be slowly extracted from or retracted onto the drum under slight tension during normal employee movement and automatically locks the drum and arrests a fall after its onset.

Rigging – (1) the hardware or equipment used to safely attach a load to a lifting device. (2) The process of safely attaching a load to a hoist by means of adequately rated and properly applied slings or related hardware.

Rolling block (snatch block) – a single or double sheave block arranged so that one or both cheek plates can be opened permitting the block to be reeved without having to pass a free rope end through it.

Roll-out – unintentional disengagement of a snaphook caused by the gate being depressed under torque or contact while twisting or turning; a particular concern with single-action snaphooks that do not have a locking gate keeper.

Rope grab – a deceleration device that travels on a lifeline and automatically, by friction, engages the lifeline and locks so as to arrest the fall of an employee. A rope grab usually employs the principle of inertial locking, cam/level locking, or both.

Safety monitor – A competent person designated to monitor the safety of other employees for leading edge fall protection.

Safety-monitoring system – an OSHA recognized (subpart M) fall protection system in which a competent person is responsible for recognizing fall hazards at leading edges and warning employees of them.

Safe working load – load that a piece of rigging equipment can carry safely based on a designed capacity reduced by a factor of safety.

Sealant – a flexible material used to seal joints between precast concrete units and between such units and adjacent materials.

Self-retracting lifeline/lanyard – deceleration device containing a drum-wound line that can be slowly extracted from or retracted onto the drum under slight tension during normal employee movement and automatically locks the drum and arrests a fall after its onset.

Shackle – a U-shaped piece of metal secured with a clevis pin or bolt across the opening used as a connecting link in rigging.

Shall – mandatory.

Sheave – a grooved wheel used to accept and support a wire rope. Used to change the direction of a wire rope.

Should – recommended.

Site-specific erection plan – A plan developed as a collaborative effort between the precaster and erector to ensure stability and safety during the erection process.

Sling – a system of wire ropes, chains, fiber ropes, or web straps used to securely attach a load to a crane hook.

Snaphook – a connector composed of a hook-shaped member with a normally closed keeper, or similar arrangement, that may be opened to permit the hook to receive an object and, when released, automatically closes to retain the object. Snaphooks should be: the locking type with a self-closing, self-locking keeper that remains closed and locked until unlocked and pressed open for connection or disconnection.

Snatch block – see Rolling block.

Softener – non-metallic material placed between precast concrete and other material and used as a cushion to prevent damage to precast concrete or rigging where slings pass around sharp corners of objects being hoisted.

Spreader beam/bar/strut – a structural rigging fitting used to spread the legs on a sling to provide vertical loading only on a load being lifted.

Spreader set – a pair of slings suspended from a load block to provide multiple-point attachment to a load.

Stability plan – a plan developed as a collaborative effort between the precaster, erector, and, when necessary, other parties that addresses issues relating to or affecting the stability of a structure during erection.

Stiffleg derrick – a derrick whose boom is supported by wire ropes running between the boom tip and the top of a structural mast supported by two structural legs running from the mast tip to the supporting surface.

Strongback – a temporary structural beam or truss bolted or welded to the back of a precast concrete member to stiffen or reinforce it during shipping and handling operations.

Surcharge – earth pressure caused by the weight of the crane or by ground surface that is above the level of the top of a wall.

Swaged fittings – a metal sleeve that is cold-formed onto the wire rope.

Swing – rotation of the mast or boom for movements of loads in a horizontal direction about the axis of rotation.

Swing clearance – the areas within the swing radius of the rear of the rotating superstructure of the crane that are free of obstructions with employee entry into areas prevented.

Swivel plate – a specialized alloy steel device that bolts to anchors cast into the member and includes a D-ring for the attachment of the hoisting sling.

Tagline – a rope attached to a precast concrete unit during erection to assist in control of a load.

Tandem lift – using two units of hoisting equipment to lift a single precast concrete member.

Tie-off – the act of a worker securing the end of a lanyard directly or indirectly to an anchorage point. Note: The terms tied off, tying off (tieing off) are related to tie-off. An anchorage point is sometimes referred to as a tie-off point.

Toeboard – a low protective barrier used in a guardrail system that will prevent the fall of materials and equipment to lower levels and provide protection from falls for personnel.

Trip – rotating a precast concrete member using two hoist lines.

Turnbuckle – a device attached to wire rope for making limited adjustments in length. It consists of a barrel and right- and left-hand threaded bolts.

Two-blocking – the condition in which the traveling lower load block or hook assembly comes in contact with the upper load block or boom point sheave assembly.

Unprotected sides and edges – means any side or edge (except at entrances to points of access) of a walking/working surface, such as a floor, roof, ramp, or runway, where there is no wall or guardrail system at least 39 in. high.

Walking/working surface – means any surface, whether horizontal or vertical, on which an employee walks or works, including but not limited to floors, roofs, ramps, bridges, runways, formwork, and concrete reinforcing steel (but not including ladders, vehicles, or trailers) on which employees must be located in order to perform their job duties.

Warning line system – a barrier erected on a roof to warn employees that they are approaching an unprotected roof side or edge; designates an area in which work may take place without the use of guardrail, full body harness, or safety net systems to protect employees in the area.

Whip line – auxiliary hoist line.

Work area – that portion of a walking/working surface where job duties are being performed.

Working load – the external load in pounds applied to the hoisting equipment, including the weight of the load: attaching equipment, such as hoisting ropes, lower load block, shackles and sling, as well as the weight of the load.

CHAPTER 1
PROJECT PRE-PLANNING

Safety on the erection site begins with pre-job planning. The site foreman will delegate job assignments and instruct the crew as to any specific safety hazards.

All personnel should be aware that erection of any precast concrete element is potentially hazardous and that the purpose of the pre-planning process is to identify hazards and control any risk in the erection process. Although the probability of risks may be small, the consequences of a failure can be death, serious injury, or damage to the building or equipment.

Before the start of work, and during construction, a competent person shall make regular surveys of the site conditions to determine the potential hazards: both physical hazards (such as equipment and housekeeping deficiencies) and personnel hazards (such as unsafe procedures and activities). The competent person shall also determine the safeguards necessary to erect precast concrete in a safe manner.

A. Review of Erection Drawings and Erection Safety Plans

1. Review the overall building configuration and erection drawings/erection safety plans to ensure that structural stability will be maintained at all times during the construction phase.
2. Review the anticipated overall construction sequence to ensure that each stage can be safely done without impacting concurrent work of other trades, as well as your own.
3. Develop a site-specific job hazard analysis and review the erection safety plan (see Chapter 9) for fall protection requirements. Ensure that all material and equipment required for protecting employees against a fall is (or will be) available in a timely manner.
4. Review the erection safety plan and erection drawings to ascertain guying, bracing, or shoring requirements, or temporary or permanent connections to be made to ensure stability during the erection phase of the project.
5. Review all types of connections and general phases of construction to ensure that the work can be accomplished by employees working in safe conditions.
6. Before authorizing the commencement of precast concrete erection, the owner/general contractor should ensure that the precast concrete erector is provided with the following written notifications:
   a. The concrete in the footings, piers, and walls and/or mortar in the masonry piers have attained, on the basis of appropriate ASTM standard test methods of field-cured sample, either 75% of the specified minimum compressive strength or sufficient strength to support the loads imposed during precast concrete erection.
   b. Any repairs, replacements, and modifications to the anchor bolts were conducted as directed by the engineer of record.
   c. The structural elements to receive the precast concrete have been accepted by the designated approval authority.
7. Ensure that all personnel have received or are given fall protection training.

B. Access for Crane and Trucking

1. Review the construction sequence for both precast concrete erection and other trades that will be working on the site at the same time to ensure that cranes and delivery trucks can safely move onto the site and around and into the structure without being limited by open excavation, overhead power lines, underground utilities (new or existing), or underground tanks or tunnels.
2. Determine the areas in which the crane will set up and verify that the ground is level. Give consideration to surcharge on nearby retaining walls or slope distance in the case of banks or ditches. Take appropriate safety measures, such as the following:
   a. Changing the sequence, setup location, or size of equipment
   b. Changing the conditions causing the unsafe practice, that is, provide or replace fill
   c. Using mats or shoring to adequately distribute load
3. Review the areas in which the crane and lifting will be done to ensure that obstructions and overhead power lines do not limit the crane throughout its entire operation. Include breaking the crane down, as necessary, at the end of the job. Determine whether power lines must be de-energized or relocated.
4. Verify that the sequence of construction allows for safe swinging of load from trucks to point of erection, which should include potential interference from guy cables and taglines.
5. Verify that access from public right of ways can be